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B3A

(54) Shaped charge liners

(57) In a method of making an annular-shaped charge of a high explosive, a correspondingly-shaped liner of angle cross-section is fabricated by a method including the step of mutually abutting sections or rings sliced from pre-formed copper hollow ware of frusto-conical configuration of which the angle of divergence (or convergence) is 180° less the value of the linear cross-section angle required. Thus, the need for bending rolls capable of accomodating copper strip of angle cross-section is dispensed with.

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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

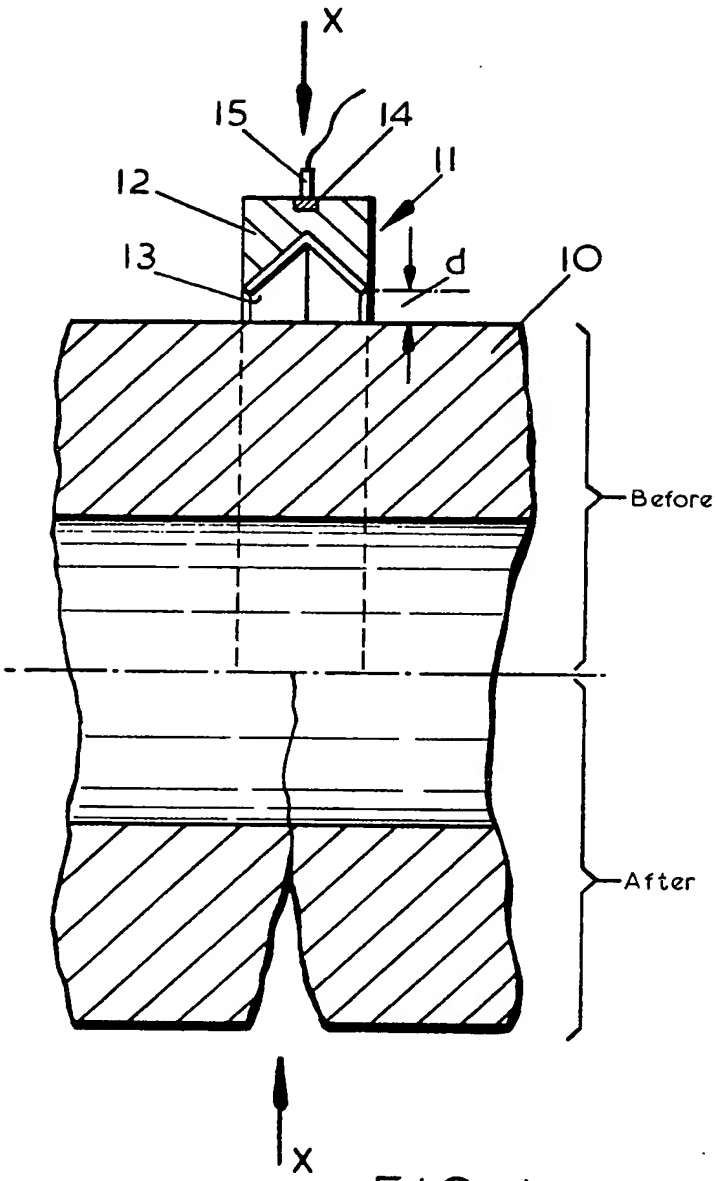

FIG. 1

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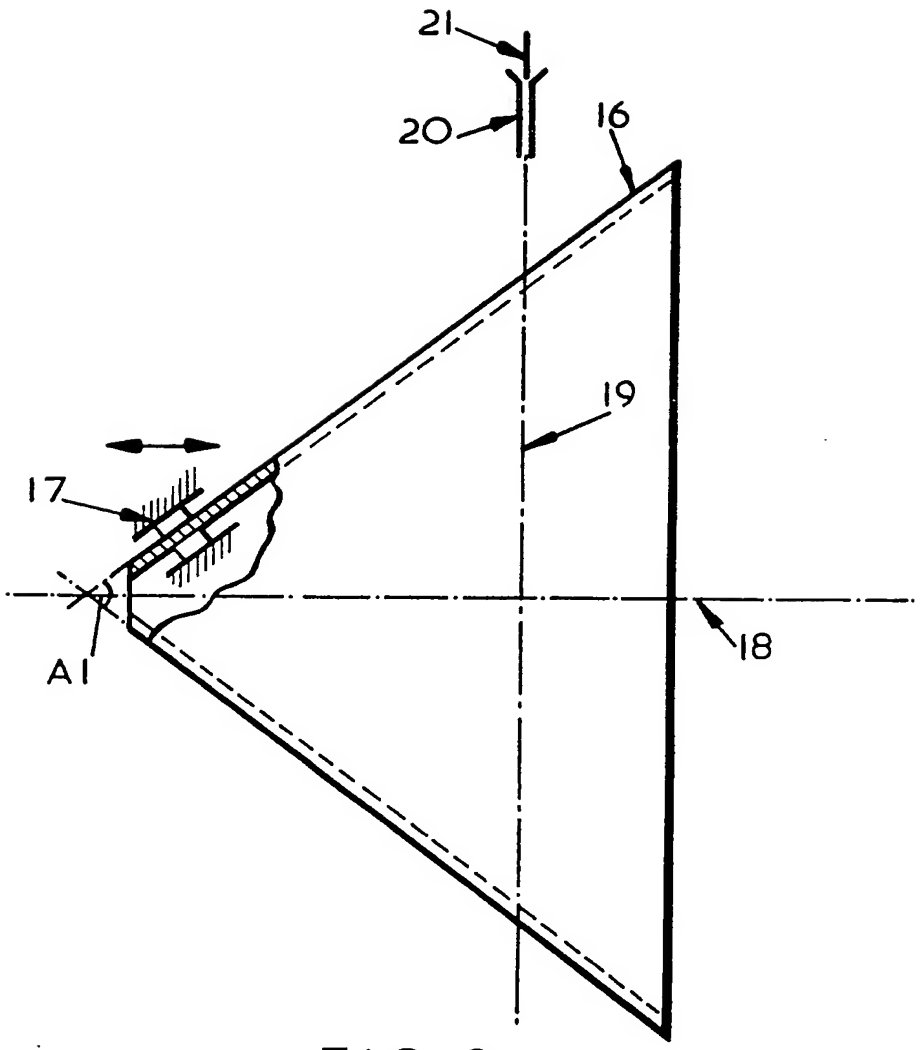

FIG. 2

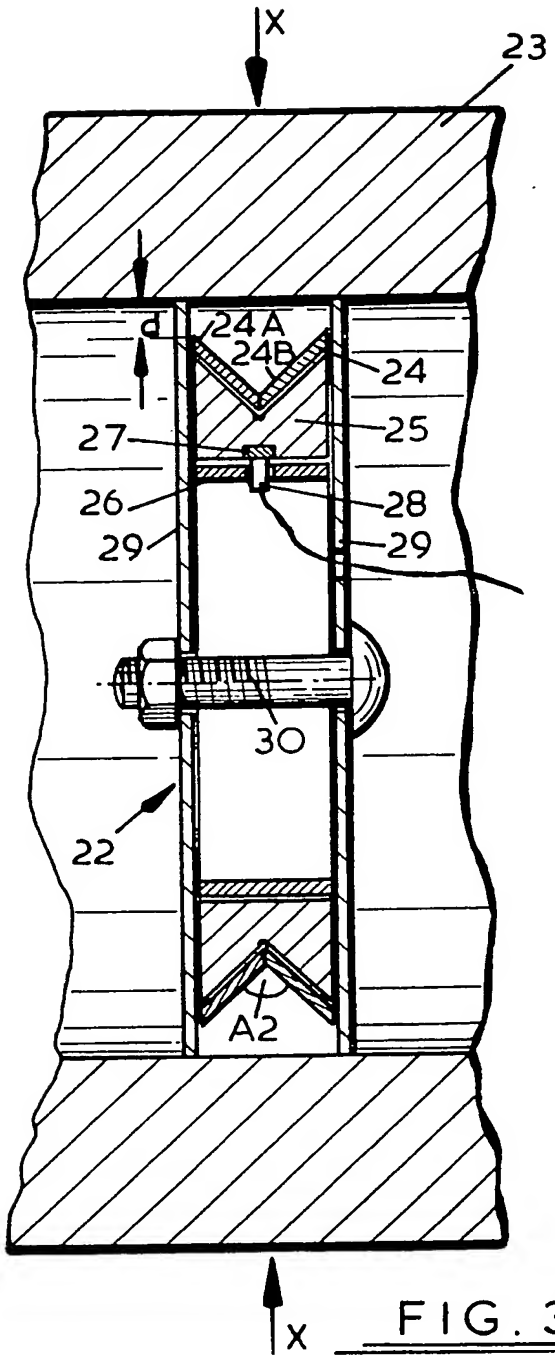

FIG. 3

SPECIFICATION

Explosive charges

This invention relates to explosive charges. The invention particularly concerns shaped charges of a high explosive, and a method of making such shaped charges.

It is known how to shape a charge of a high explosive to produce convergent detonation waves with a resultant penetrating jet capable of parting dense materials, for example high tensile steel. This penetrating capability is increased if the shaped portion of the charge is lined with a layer of a dense material, for example copper. Accordingly, the making of shaped charges of a high explosive involves also the making of lining strips, usually of copper, of angle cross-sectional configuration. Where lined charges are to be fitted to curved (or non-linear) members, a difficulty arises from the need to form the angle-sectioned liner to the desired curvature. This forming is presently achieved by means of bending rolls capable of accommodating the angle section of the liner, the said difficulty being that such bending rolls are not always conveniently available, expecially where the final charge forming is completed in the field as in highly specialised cutting applications in both military and civil situations.

An object of the present invention is to provide a shaped charge of a high explosive and/or a method of making such a charge wherein the aforesaid difficulty is obviated or mitigated.

According to the present invention, a shaped charge of a high explosive has a liner of angle cross-section comprising mutually abutting pre-formed sections each of diverging (or converging) configuration of which the angle of divergence (or convergence) is 180° less the value of the liner cross-section angle.

Further, according to the present invention, there is provided a method of making a shaped charge of high explosive, comprising fabricating a liner of angle cross-section by abutting sections sliced from pre-formed hollow ware of diverging (or converging) configuration of which the angle of divergence (or convergence) is 180° less the value of the liner cross-section angle.

Further, according to the present invention, there is provided a liner of angle cross-section for a shaped charge of high explosive made as aforesaid.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:–

Figure 1 is a diagrammatic representation in sectional elevation of part of a thick-walled tubular member prepared in the upper part of the drawing for parting by means of a conventional shaped charge of a high explosive; and in the lower half of the drawing the parting/fracture following detonation;

Figure 2 is a diagrammatic representation in part/section elevation of a frusto-conical stock piece set up for the cutting of smaller frusto-conical slices therefrom;

Figure 3 is a diagrammatic representation in sectional elevation of part of a tubular member with an assembled explosive charge within the member for parting thereof on detonation, the explosive charge incorporating the liner in accordance with the present invention.

In Fig. 1 of the drawings, a tubular member 10, for example part of a steel-reinforced concrete pipeline requires to be parted for demolition purposes on a line indicated generally by arrows X–X. The parting will be effected by means of a shaped explosive charge indicated generally by reference numeral 11 in the upper half of Fig. 1. In conventional manner, the charge 11 consists of high explosive material 12, an angle cross-section copper liner 13, a booster charge 14 and a detonator 15. In the interests of clarity, containment hardware for the explosive charge has been omitted in Fig. 1. The shaped charge is formed to the configuration of the outside surface of the member 10 and so forms an annulus therearound with a stand-off dimension indicated in Fig. 1 by letter *d*. After detonation of the charge 11, the tubular member 10 is parted/fractured generally as appears in the lower portion of Fig. 1. Associating the foregoing with convention assumes that the angle-section liner 13 is made from angle-section copper strip formed to the outer configuration of the tubular member 10 by means of bending rolls in known manner.

In the manufacture of liners for shaped charges of high explosive, it is important that the liner configuration be smooth; that is to say without surface or shape irregularities which would adversely affect the operation of the charge. Accordingly, it is not practically feasible to form the angle-section copper strip to a desired curvature without the use of machinery such as bending rolls.

The proposals in accordance with the present invention are now described with reference to Figs. 2 and 3. The present invention envisages a method of making a charge liner by slicing sections from pre-formed hollow ware of diverging (or converging) configuration. Thus, in Fig. 2, a pre-formed hollow ware item 16 consists of a hollow body of frusto-conical configuration formed from a sheet of copper. The forming process may be achieved by any convenient metal forming technique, for example, spinning, rolling or casting. The wall thickness of the hollow ware item 16 may be constant as appears in Fig. 2, or the wall thickness may vary according to any desired formula. The angle of divergence (or convergence) of the hollow ware item or "stock piece" 16 is denoted by A1 in Fig. 2.

It is to be assumed that a plurality of stock pieces 16 is provided.

In order to effect slicing of a stock piece, the latter is to be held in a jig which is not shown in detail in Fig. 2, but is denoted by reference numeral 17 in diagrammatic fashion. The jig 17 serves to hold the stock piece 16 true with respect to its axis 18 which is normal to a cutting plane 19 defined by means of a saw guide 20 for receiving and guiding a hand-saw of which the blade is shown as at 21. The jig 17 permits position-adjustment along the axis 18 of the stock piece 16 with respect to the cutting plane 19. It is envisaged that the jig 17 will incorporate graduation marks to enable cutting of the stock piece 16 to any diameter desired within the range of diameters available from any given stock piece.

In order to produce an annular liner, two mutually similar slices are cut one from each of two stock pieces and are brought into mutually abutting engagement to produce an angle-section with the option that the latter may face either inwardly or outwardly. Preferably, the two slices are mutually secured by means of an adhesive. Thus, an accurately fabricated liner of angle-section is produced in the field by means of a simple saw-cut and obviating the need for bending rolls.

In Fig. 3, an explosive charge assembly indicated generally by reference numeral 22 is shown placed internally within a tubular member 23 to be parted on the line X–X. The assembly 22 consists of an annular liner 24 of angle-section itself consisting of slices 24A and 24B obtained from stock pieces as described with reference to Fig. 2. A high explosive material 25 backing the liner 24 is retained by an inner annular retainer 26 carrying a conventional booster charge 27 and detonator 28. The shaped charge is carried between side plates 29 which are held by a clamping bolt 30. The peripheral edges of the side plates 29 abut the inner surface of the tubular member 23 and provide the stand-off distance *d* required.

The foregoing description deals only with the making of shaped charges of annular configuration for which annular forms of liner may be made from frusto-conical stock pieces. It is within the scope of the present invention to produce shaped charges for fitting to rectilineal forms by designing stock pieces having appropriate configurations. In all cases, the angle of divergence (or convergence) of the stock piece or hollow ware will be 180° less the value of the desired liner cross-section angle. This, in Fig. 3, the liner cross-section angle is shown as a 2. $A1 = 180° - A2$ (and vice-versa).

A development of the method described above, and of the present invention, is the preparation of kits of parts including inter alia sets of stock pieces, sawing jigs and charts whereby a wide range of charge liners may be produced readily in the field to meet instant requirements.

CLAIMS

1. A shaped charge of a high explosive having a liner of angle cross-section, the liner comprising mutually abutting pre-formed sections each of diverging (or converging) configuration of which the angle of divergence (or convergence) is 180° less the value of the liner cross-section angle.

2. A shaped charge according to claim 1, wherein each said pre-formed section is of frusto-conical configuration.

3. A method of making a shaped charge comprising fabricating a liner of angle cross-section by abutting sections sliced from pre-formed hollow ware of diverging (or converging) configuration of which the angle of divergence (or convergence) is 180° less the value of the liner cross-section angle.

4. A liner of angle cross-section for a shaped charge of high explosive, the liner comprising mutually abutting sections of pre-formed holloware.

5. A kit of parts for use in making liners for shaped charges of high explosive, the kit comprising sets of stock pieces of holloware of frusto-conical configuration.

6. A shaped charge of high explosive, substantially as hereinbefore described with reference to and as shown in Fig. 3 of the accompanying drawings.

7. A method of making a shaped charge of a high explosive, substantially as hereinbefore described.

8. A method of making a liner for a shaped charge of high explosive, substantially as hereinbefore described.

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